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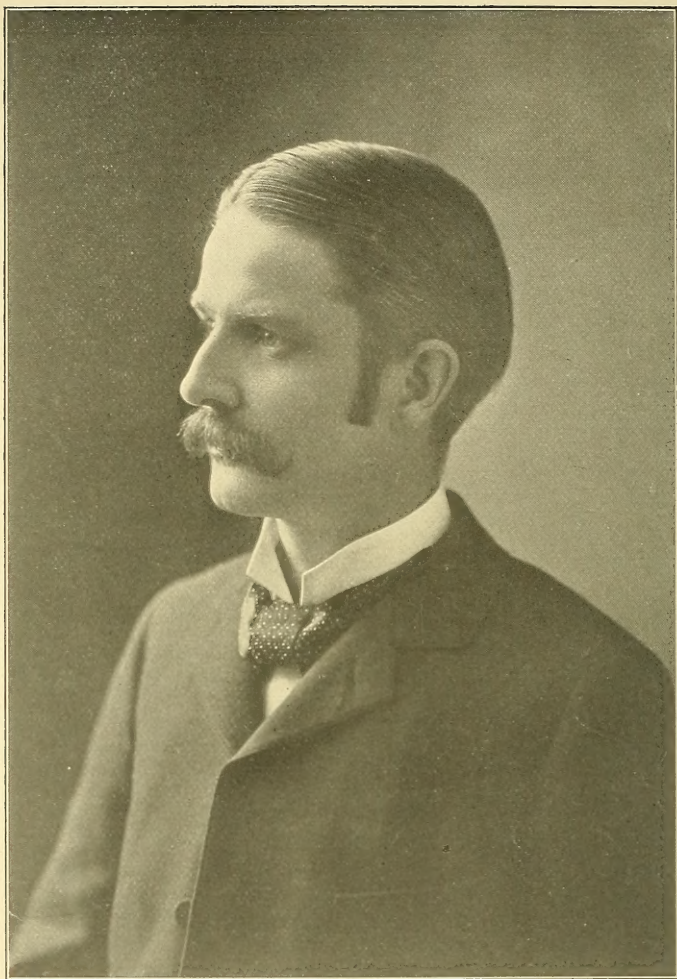
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[FROM THE AMERICAN JOURNAL OF SCIENCE, VOL. XVII, June, 1904.]

CHARLES EMERSON BEECHER.

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CHARLES EMERSON BEECHER.

ONE of America's leading paleontologists, in the fullness of intellectual power, suddenly passed away on February 14, 1904, in the midst of his family and work. Few men were better prepared and more promising of great results for the next twenty years than Charles E. Beecher. "There is no doubt that in the death of Professor Beecher, not only has Yale sustained a serious loss and paleontology a severe blow, but the ranks of those capable of bringing to the study of fossils keen insight and a philosophical spirit of enquiry, guided by principles whose value can hardly be exaggerated, are diminished by one whom science could ill afford to lose, and to whom, humanly speaking, there should have remained many years of industry and fruitful research." (W. H. Dall, *Science*, March 18, 1904.)

Like most successful students of organic life, Beecher was a born naturalist. As a boy of twelve years he began to make a collection of recent shells and fossils, continuing to add to this for the next thirty years, when, in 1899, he presented Yale University, "unconditionally," with upwards of 100,000 fossils. In the field few excelled Beecher as a collector. When twenty years of age he published his first paper—a list of the land and fresh-water shells of Ann Arbor, Michigan. For the next eight years he published nothing, his second paper appearing in 1884, and in 1888, when he left Albany,

there were but twelve papers to his credit. Since that time, during the years spent at New Haven, he has written fifty-eight articles, making a total of seventy numbers in his bibliography. As a paleontologist he began by describing species and genera, but later he took almost no interest in this kind of work. Often he told the writer that he wished all our fossils were named. Of faunal and stratigraphic papers he has five, and of new species he described but thirty-six. He defined nine new genera and seven new orders. During the past fifteen years his mind was absorbed in working out the ontogenetic stages in fossil species and in tracing their genetic sequence through the geological formations. To Beecher we owe the first natural classification of the Brachiopoda and Trilobita, based on the law of recapitulation and on chronogenesis. He also gave a very philosophic account as to the origin and significance of spines in plants and animals. On these works his reputation in days to come will chiefly rest.

Beecher was not only a born naturalist but also had much mechanical ability. Nothing pleased him more than to free fossils from the surrounding matrix, and his unexcelled talent in this direction is shown in the preparations of *Triarthrus* and *Trinucleus* in the Yale University museum. More than 500 specimens have been prepared by him and this work has required peculiar skill, patience, ingenuity, and a great deal of time. Few can appreciate Beecher's remarkable talent in cleaning the adhering black shale from these small specimens, and it will be a long time before another will be found who can equal him in this respect. It is very unfortunate that he did not live to complete his studies on the trilobites, but he left all the better specimens completely worked out, and of most of these he had made photographs and drawings. His mechanical bent was also evidenced at his home, where he had a bench and a large kit of tools. Here his diversion consisted in making brass scrolls, shelves, and delicately carved boxes and chests. His preparations for the microscope, also, are of the best, and much time in his earlier years was spent in freeing and mounting the lingual dentition in small species of living gastropods. He likewise modeled and made a life-size restoration of the Devonian giant *Stylonurus*.

After Beecher's appointment as Curator of the geological collections at Yale, he also undertook to arrange, develop, and place on exhibition the large Marsh collection of vertebrates. His work in this connection, however, was chiefly directive, although he assisted considerably in the mechanical work of the large mounts of *Claosaurus annectens* and *Brontosaurus*. The life-like poses selected for these specimens are evidences of his artistic perception. The former he has described at length in the Transactions of the Connecticut Academy.

Charles Emerson Beecher, son of Moses and Emily D. Beecher, was born in Dunkirk, New York, October 9, 1856. Not long after this date, his parents removed to Warren, Pennsylvania, where he prepared for college at the High School, and was graduated from the University of Michigan, receiving the degree of B.S. in 1878. The ten succeeding years he served as an assistant to Professor James Hall, and in 1888 removed to New Haven to take charge of the collections of invertebrate fossils in the Peabody Museum. His career as a teacher of geology began in 1891 when for two years he took charge of Dana's classes at Yale, and in 1892 he was made Assistant Professor of Historical Geology in the Sheffield Scientific School, serving in this capacity until 1897 when he became Professor of Historical Geology and a member of the Governing Board in the Sheffield Scientific School. In 1899 he succeeded the late Professor Marsh as Curator of the geological collections, and was made a member of, and secretary to, the Board of Trustees of the Museum. In 1902 his title was changed to that of University Professor of Paleontology. He was eminently successful as a teacher both with undergraduates and with advanced students, his enthusiasm and kindliness of character arousing at once their interest and devotion.

Professor Chittenden, director of the Sheffield Scientific School, has said of Beecher: "Quiet and unassuming he never sought adulation, but where there was earnest work to be done, requiring skill, patience and good judgment, he would labor quietly and industriously, bringing to bear upon the problem such a measure of common sense and of thoughtfulness that confidence and respect for his conclusions were inevitable.

..... As a friend he was loyal and trustworthy, and his memory will always be cherished by his associates in the Sheffield Scientific School with a full realization of the great loss they have sustained in his removal from their midst, and with an equal realization of the great loss to the institution to which he was so ardently devoted and in the future of which he had such great confidence."

Beecher received the degree of Ph.D. from Yale in 1889, his thesis being a memoir on the Ordovician Brachiospongiadæ. In 1899 he was elected a member of the National Academy of Sciences, a foreign correspondent of the Geological Society of London, and a fellow of the Geological Society of America. In 1900 he was elected President of the Connecticut Academy of Arts and Sciences, and filled this office for two years. He was also a member of the American Association of Conchologists, Geological Society of Washington, Boston Society of Natural History, and Malacological Society of London.

Beecher's first paleontologic paper was published by the Geological Survey of Pennsylvania in 1884, when he was twenty-eight years old. It treated of new genera and species of Phyllocarida from the Devonian, a group of rare Crustacea, most of which he had found about his home. He was always on the lookout for these rare fossils, and after securing many hundred additional specimens, he again returned to the subject, and in 1902, in a paper published by the Geological Society of London, embodied all that is known of the Upper Devonian Phyllocarida of Pennsylvania.

If, during the past ten years, Beecher's time had not been so much taken up with trilobites, he probably would have worked out a phylogenetic classification of the corals. In 1891 he published two important papers on paleozoic corals, one based on *Pleurodictyum lenticulare* and the other on *Michelinia convexa*. He concluded that poriferous corals begin with a simple cyathiform corallite, without mural pores, and with septa first appearing toward the end of this stage. These features "indicate a primitive, simple, and imperforate ancestry for the Perforata." The next stage is suggestive of *Aulopora*, and the final stage in *P. lenticulare* has at least seven mural pores open-

ing into the primary calyx. In regard to the mural pores, he concluded from a study of them in *Favosites*, *Striatopora*, *Pleurodictyum*, and *Michelinia*, that they "are ineffectual attempts at budding, resulting only in the perforation of the cell walls."

In his third paper on corals he states that a specimen of *Romingeria umbellifera* measuring $100 \times 200^{\text{mm}}$ has approximately 1500 corallites on each zone, or 4500 on the three zones. In 85 per cent of individuals each corallite gives rise to twelve buds, so that if each of the 1500 corallites of the basal zone give rise to twelve buds, there should be on the third zone 253,500 corallites. However, as there are only 4500 in the specimen in the three zones, "this shows a suppression of 243,000 corallites on two zones."

Beecher's first turn from stratigraphic paleontology to pure paleo-biology and correlation had its origin in the brachiopods. While at Albany he became acquainted with Hyatt's principles, although it was not until he had been some years at New Haven that he fully appreciated their application to fossils. Hall had made large collections of the Silurian fossils at Waldron, Indiana. This collection contained many slabs, and, as much loose clay adhered to them, Beecher saved the washings and out of these he and Clarke obtained about 50,000 specimens of young brachiopods. Their results were published in 1889 in a well-illustrated paper entitled "Development of some Silurian Brachiopods." In summing up the developmental changes, they made the following very significant statement: "In nearly every species the inceptive state is represented by a shell having a subcircular outline, with valves of slight convexity. This phase usually disappears before the individual reaches a length of 1^{mm} , after which the specific characters are assumed." Widely differing species "are alike in form, contour, convexity, beaks, and cardinal area, and the only marked differences are to be found in the faint indications of plications, striæ, folds and sinuses."

From a study of the nature of the pedicle opening they concluded that the "phylogenetic development tended in two main channels—one leading through *Strophomena*, *Scenidium*, *Orthosina*, *Leptæna*, *Chonetes*, *Productus*, and *Strophalosia*, and the other in the direction of *Rhynchonella*, *Spirifer*,

Atrypa, *Retzia*, and *Terebratula*." It will be noticed that this arrangement of widely differing genera foreshadows two orders of brachiopods for which Beecher later proposed Neotremata and Telotremata.

My acquaintance with Beecher began in 1889, and at that time it was evident that the paper just referred to was being considered with a better understanding of what Hyatt's principles meant when applied to Brachiopoda. The very fact that nearly all the Waldron, Indiana, brachiopods began with smooth shells having a subcircular outline, led him to look for this early stage in other genera, but as no other young shells were at hand, he resorted to a study of the beaks in well-preserved examples of mature shells. During the fall of 1890 he spent nearly a week going through my collection, and with studies made on other collections he was able to announce in the spring of 1891 that he had seen the initial shell in fifteen families as recognized by Ehlert in Fischer's "Manuel de Conchyliologie," these being represented by forty genera.

At this time he made the important announcement "that all brachiopods, so far as studied by the writer, have a common form of embryonic shell, which may be termed the *protegulum*." The *protegulum* is the phylembryonic stage of Brachiopoda. A prototype preserving throughout its development the main features of the *protegulum* was at first supposed to exist in the Lower Cambrian *Paterina*, but as this proved to be identical in structure with *Iphidea*, the conclusion had to be abandoned. However, at maturity this genus is so closely related in general form with the *protegulum*, that we may hope at any time to find the prototype.

A study of the stages of growth in many brachiopods, from the Cambrian to the living forms, enabled Beecher to show that the old classifications based upon the presence or absence of hinge teeth, the nature of the intestinal canal, etc., were not expressive of genetic relationship. He demonstrated that on the basis of types of pedicle openings all brachiopods are naturally grouped into four orders, of which two are without and two possess hinge teeth. The most primitive order (*Lingula*, etc.) he named Atremata, and this gave rise directly to the Telotremata (*Rhynchonella*, *Terebratula*, etc.). The Neotremata (*Crania*, *Discina*, etc.) also originated in the Atremata,

and from the former descended the Protremata (*Strophomena*, *Productus*, etc.).

One of the clearest cases of parallelism between the ontogeny and phylogeny in a group of invertebrates was described by Beecher. Living species of the family Terebratellidæ have a very wide distribution, and he showed that the highest genera of the austral forms "pass through stages correlated with the adult structure in the genera *Gwynia*, *Cistella*, *Bourchardia*, *Megerlina*, *Magas*, *Magasella*, and *Terebratella*, and reach their final development in *Magellania*." In the forms having a boreal distribution the metamorphoses correlate "with adult structures of *Gwynia*, *Cistella*, *Platidia*, *Ismenia*, *Mühlfeldtia*, *Terebratalia*, and *Dallina*. The first two stages in both subfamilies are related in the same manner to *Gwynia* and *Cistella*. The subsequent stages are different except the last two, so that the *Magellania* structure is similar in all respects to the *Dallina* structure, and *Terebratella* is like *Terebratalia*. Therefore *Magellania* and *Terebratella* are respectively the exact morphological equivalents to, or are in exact parallelism with *Dallina* and *Terebratalia*.

"In each line of progression in the Terebratellidæ, the acceleration of the period of reproduction, by the influence of environment, threw off genera which did not go through the complete series of metamorphoses, but are otherwise fully adult, and even may show reversional tendencies due to old age; so that nearly every stage passed through by the higher genera has a fixed representative in a lower genus. Moreover, the lower genera are not merely equivalent to, or in exact parallelism with, the early stages of the higher, but they express a permanent type of structure, as far as these genera are concerned, and after reaching maturity do not show a tendency to attain higher phases of development, but thicken the shell and cardinal process, absorb the deltidial plates, and exhibit all the evidences of senility."

In 1893 there was discovered in the Utica formation near Rome, New York, a thin band not more than one-fourth of an inch thick, in which nearly all the fossils preserved (*Triarthrus* and *Trinucleus*) occur as pseudomorphs in iron pyrite, and retain antennæ and legs. Specimens of trilobites with legs had been known before in two specimens, and in four genera

the legs had been determined by slicing enrolled individuals. Antennæ, however, had not been clearly made out until 1893, when their presence was announced in the August number of this Journal. This discovery was of great value and promised much toward a better understanding of the ventral anatomy of trilobites and their systematic position among the Crustacea. This led to Beecher's visiting the locality in 1893 to take out several tons of the shale. Even as late as last fall he developed from this material specimens of *Trinuclæus* showing the ventral appendages in the greatest detail. Since 1893 Beecher has published fifteen papers on the trilobites. Of these three are devoted to the larval stages, seven to the ventral anatomy, and five to classification and the systematic position of these forms.

The ventral anatomy is most completely known in *Triarthrus*, "an active creature" belonging to an ancient Cambrian family. Beecher showed that in this genus the entire series of thoracic legs are biramous, one of them setæ-bearing and used for swimming (exopodite), and the other without setæ and used for crawling (endopodite). The limbs of the pygidium overlap each other, are much crowded, and are adapted for swimming or guiding the animal, although they may also have served as egg carriers. The individual segments "are considerably expanded transversely, thus making a paddle-like organ." The head has five pairs of appendages as follows: Anterior antennæ or uniramous antennules attached at the side of the hypostoma, followed by four pairs of biramous appendages closely resembling the thoracic legs. These are (1) posterior antennæ, (2) mandibles, (3 and 4) maxillæ. The ventral membrane of *Triarthrus* "is of extreme tenuity" and is an "uncalcified, chitinous, flexible pellicle, and thus was in strong contrast with the much thicker and calcified dorsal test."

The larval stages he studied in nine genera ranging from the Cambrian to the Lower Devonian. He concluded that "all the facts in the ontogeny of the trilobites point to one type of larval structure." This larva, not more than one millimeter in length, is "characteristic of all trilobites, and among different genera, varying only in features of secondary importance. This stage may therefore be called the *protaspis*." He found that Barrande's four orders of trilobite development are but stages of his first order, and that *Agnostus* is "neither

the phylo-tyembryo nor the phylo-phylembryo, but is really the adult equivalent to an early segmented stage of the higher genera." Beecher divided the early stages of development in trilobites as follows: "Nauplius (Cephalon predominating, other parts not separated from it), Phylembryonic (Cephalon distinct, thorax nothing, pygidium distinct), Nepionic with as many stages as there are normal thoracic segments (Cephalon distinct, thorax incomplete, pygidium distinct), Neanic (Cephalon, thorax and pygidium all distinct and complete; growth incomplete), Ephebic (all parts complete and full size attained)."

The protaspis is homologous to the crustacean nauplius, which had "potentially five cephalic segments bearing appendages, which should therefore be taken as characteristic of a protonauplius. The nauplius is a modified crustacean larva. The protaspis more nearly represents the primitive ancestral larval form for the class, and approximates the protonauplius."

The basis for Beecher's classification of the trilobites is the application, for the first time, of the law of morphogenesis, or the recapitulation theory. He observed that in the first or unsegmented stage of the most primitive trilobites there are neither dorsal free cheeks nor eyes, but that in some of the later forms both the eyes and free cheeks have migrated to the anterior margin or may even have progressed a little posteriorly down the dorsal side of the protaspis. This led him to undertake a study of all trilobite genera, more than two hundred in number, and it was seen that these could be arranged in three groups on the basis of the nature and position of the free cheeks. In the most primitive order, or the Hypoparia, there are "free cheeks forming a continuous marginal ventral plate of the cephalon, and in some forms also extending over the dorsal side at the genal angles." In the Opisthoparia the dorsal "free cheeks include the genal angles, thus cutting off more or less of the pleura of the occipital segment;" while in the Proparia, or the last order to arise, "the pleura of the occipital segment extend the full width of the base of the cephalon, embracing the genal angles."

There is much diversity of opinion regarding the rank of trilobites in a classification of the Crustacea. Beecher regarded them as a sub-class and as equal in rank to the Entomostraca and Malacostraca. "In nearly every particular the trilobite is very primitive, and closely agrees with the theoretical crusta-

cean ancestor. Its affinities are with both the other sub-classes, especially their lower orders, but its position is not intermediate."

In 1892 Beecher became greatly interested in the significance of spines, accumulating data until 1898, when he presented his studies in a paper entitled "The origin and significance of spines." This paper Beecher regarded as his best and most philosophic work. In the opening paragraph he states "the presence of spines in various plants and animals is, at times, most obvious to all mankind, and not unnaturally they have come to be regarded almost wholly in the light of defensive weapons." "Their importance lies not in what they *are*, but in what they *represent*. . They *are* simply prickles, thorns, spines, or horns; they *represent*, as will be shown, a stage of evolution, a degree of differentiation in the organism, a ratio of its adaptability to the environment, a result of selective forces, and a measure of vital power."

"In tracing the ontogeny of a spinose form, it has been found that each species at the beginning was plain and simple, and at some later period, spines were gradually developed according to a definite sequence of stages. Usually after the maturity of the organism, the spines reach their greatest perfection, and in old age, there is first an over-production or extravagant differentiation followed by a decline of spinous growth, and ending in extreme senility with their total absence."

He found that all kinds of spines in plants and animals can be arranged into eleven distinct categories. Further, that two generalizations result as follows: "That spinosity represents the limit of morphological variation, and second, it indicates the decline or paracme of vitality." "Finally it is evident that, after attaining the limit of spine differentiation, spinose organisms leave no descendants, and also that out of spinose types no new types are developed."

Beecher's standing among biologists and paleontologists was high; he was a leader among students of Brachiopoda and Trilobita. His paleontologic work at Yale was essentially of a biologic and philosophic character. He had the artist's gift, nearly all the drawings illustrating his various papers being made by himself and exhibiting a high order of merit. He

was a slow and very careful worker. Those who knew him well saw in him an enthusiast, but his exuberance was always held in check by his judicial qualities, which also made him an excellent counselor. He was orderly in his work, and, as he had the "museum instinct" well developed, he made one of the best of museum curators.

In 1894, Beecher married Mary Salome Galligan of Warren, Pennsylvania, who, with two daughters, survives him. He died very suddenly of heart disease at his home, shortly after one o'clock on Sunday afternoon, February 14. Up to about eleven o'clock of the same day, he was in his usual health. He lies in Grove Street Cemetery, in the shadow of the Sheffield Scientific School.

CHARLES SCHUCHERT.

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